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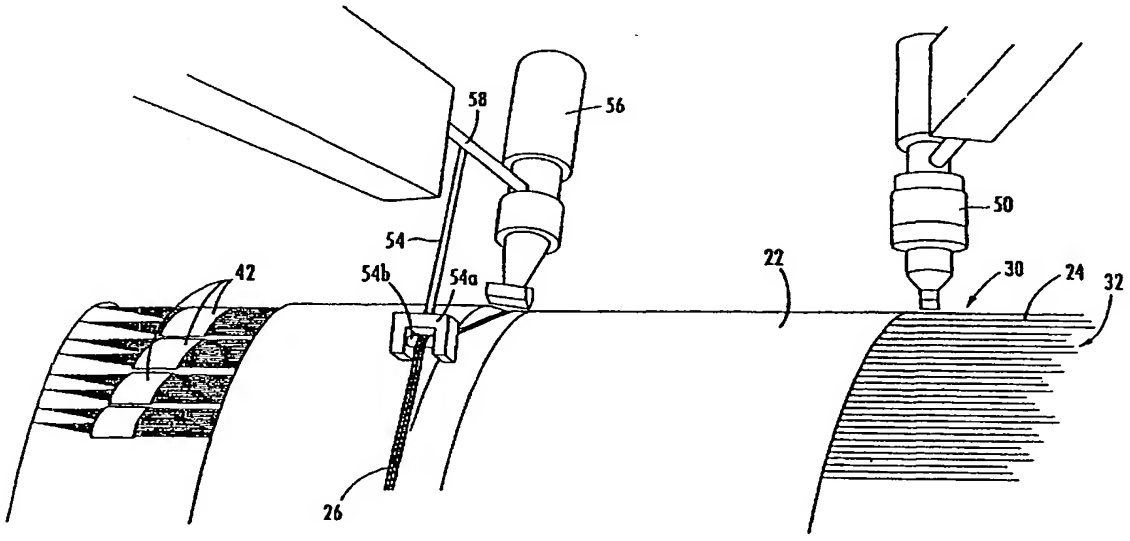
(54) Title: BELT FOR A SHOE PRESS AND METHOD FOR FORMING SAME



(57) Abstract: A method of producing an endless belt (20) includes the steps of: securing axial fibers (24) relative to a mandrel (20), the axial fibers being spaced apart from one another at desired intervals and extending substantially parallel to a longitudinal axis of the mandrel; applying a polymeric base layer (22) to the mandrel in a thickness sufficient to embed the axial fibers; wrapping circumferential fibers (26) onto the polymeric base layer with sufficient tension to partially embed the circumferential fibers in the polymeric base layer; applying a polymeric top stock layer (28) over the polymeric base layer and circumferential fibers; and curing the base layer and the top stock layer. This method can improve productivity and performance of endless belts, particularly if the wrapping and latter applying steps closely follow the first applying step.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

BELT FOR SHOE PRESS AND SHOE CALENDER AND METHOD FOR FORMING SAME

Related Applications

This application claims priority from U.S. Provisional Patent Application Serial No. 60/378,146, filed May 14, 2002, the disclosure of which is hereby incorporated herein by reference in its entirety.

Field of the Invention

The present invention relates generally to nip presses, and more particularly to shoe presses.

Background of the Invention

In a typical papermaking process, a water slurry, or suspension, of cellulosic fibers (known as the paper "stock") is fed onto the top of the upper run of an endless belt of woven wire and/or synthetic material that travels between two or more rolls. The belt, often referred to as a "forming fabric," provides a papermaking surface on the upper surface of its upper run which operates as a filter to separate the cellulosic fibers of the paper stock from the aqueous medium, thereby forming a wet paper web. The aqueous medium drains through mesh openings of the forming fabric, known as drainage holes, by gravity or vacuum located on the lower surface of the upper run (*i.e.*, the "machine side") of the fabric.

After leaving the forming section, the paper web is transferred to a press section of the paper machine, where it is passed through the nips of one or more presses (often roller presses) covered with another fabric, typically referred to as a "press felt." Pressure from the presses removes additional moisture from the web; the moisture removal is often enhanced by the presence of a "batt" layer of the press felt. The paper is then transferred to a dryer

section for further moisture removal. After drying, the paper is ready for secondary processing and packaging.

Over the last 25 or 30 years, a "shoe press" has been developed for the press section of the papermaking machine. A shoe press includes a roll or similar structure that mates with a "shoe" of an opposed roll or press structure; the surface of the shoe is somewhat concave and approximates in curvature the convex profile of the mating roll. This arrangement can increase the width of the nip in the direction of paper travel, thereby enabling greater amounts of water to be removed therein.

Endless belts or blankets have traditionally been used in shoe press operations. The belt overlies and contacts the shoe of the press; in turn, a press felt such as that described above overlies the shoe press belt, and the paper web overlies the press felt. The shoe press belt and press felt travel through the nip and, in doing so, convey the paper web through the nip. The press felt is driven by a set of drive rollers arranged around the shoe or by the press roll itself. In older embodiments, shoe press belts were also driven by sets of drive rollers arranged around the shoe. In some newer configurations, however, the shoe press belt is clamped or otherwise fixed to the edges of circular head plates located on either end of the shoe, such that rotation of the head plates causes the shoe press belt to rotate and travel through the nip.

Given the performance requirements, a shoe press belt should be sufficiently flexible to pass around the drive rollers or head plates and through the shoe and sufficiently durable to withstand the repeated application of pressure within the nip. Because of these performance parameters, most endless belts are formed entirely or predominantly of a polymeric material (often polyurethane). Many shoe press belts also include reinforcing fibers or a reinforcing fabric between or embedded in polymeric layers. Also, shoe press belts may be configured to encourage water to pass from the paper web. To this end, some shoe press belts have grooves or blind-drilled holes in the surface adjacent the press felt that serve to vent water from the paper that is exiting the press felt.

Some of the issues that arise with the manufacture of a shoe press belt are the accurate placement of reinforcing fibers within the belt (and the application of material around them). Proposed approaches to the creation of shoe press belts are discussed in, for example, U.S. Patent Nos. 5,525,194 to Jermo, 5,134,010 to Schiel, 5,320,702 to Matuschczyk, and

5,118,391 to Matuschczyk. However, there still exists a need for expediting and improving the manufacturing processes for shoe press belts.

Summary of the Invention

The present invention can facilitate the production of shoe press belts, and in particular shoe press belts having axially-extending reinforcing fibers that are positioned radially inwardly of circumferentially-extending fibers. As a first aspect, the present invention is directed to an endless belt for a shoe press, comprising: a polymeric matrix formed into an endless loop; multiple bands of axial fibers, the fibers being embedded in the polymeric matrix, the bands including spacing material at each end that maintains a desired circumferential spacing between the fibers and further including securing structure that is adapted for securing the fibers to a mandrel; and circumferential fibers that circumferentially overlie and are spaced from the axial fibers, the circumferential fibers being embedded in the polymeric matrix. In some embodiments, the polymeric matrix comprises a base layer in which the axial fibers are embedded and a top stock layer that overlies the circumferential fibers. The sheet material and securing structure can maintain the axial fibers in a desired position and spacing during the production of the belt.

As a second aspect, the present invention is directed to an endless belt for a shoe press comprising: a polymeric base layer formed of a first polymeric material; axially extending fibers embedded in the base layer; circumferential fibers that circumferentially overlie the polymeric base layer; and a polymeric top stock layer that circumferentially overlies the circumferential fibers, the top stock layer being formed of a second polymeric material that differs from the first polymeric material. In this configuration, the belt can include one material that is particularly suited for contact with a shoe press and another material that is particularly suited for contact with a press felt.

As a third aspect, the present invention is directed to a method of producing an endless belt, comprising the steps of: securing axial fibers relative to a mandrel, the axial fibers being spaced apart from one another at desired intervals and extending substantially parallel to a longitudinal axis of the mandrel; applying a polymeric base layer to the mandrel in a thickness sufficient to embed the axial fibers; wrapping circumferential fibers onto the polymeric base layer with sufficient tension to partially embed the circumferential fibers in the polymeric base layer; applying a polymeric top stock layer over the polymeric base layer

and circumferential fibers; and curing the base layer and the top stock layer. This method can improve productivity and performance of endless belts, particularly if the wrapping and latter applying steps closely follow the first applying step.

Brief Description of the Figures

Figure 1 is a front section view of a shoe press belt manufactured by the process of the present invention.

Figure 2 is a front view of a mandrel employed in the process of the present invention.

Figure 3 is an enlarged partial front view of an end portion of the mandrel of **Figure 2** with axial fibers mounted thereon.

Figure 4 is a front view of the mandrel of **Figure 2** with axial fibers mounted thereon.

Figure 5A is a top view of a band of axial fibers (including its laminated ends) to be included in a shoe press belt according to the present invention being formed on a fixture.

Figure 5B is a front view of the band of axial fibers and the fixture of **Figure 5A**.

Figure 6A is an enlarged top view of one end of the band of axial fibers of **Figure 5A**.

Figure 6B is an enlarged top view of one end of an alternative laminated section of a band of axial fibers according to the present invention.

Figure 7 is a perspective view of the mandrel of **Figure 2** with base layer and top stock nozzles and a circumferential fiber applicator.

Detailed Description of the Invention

The present invention will now be described more fully hereinafter, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, like numbers refer to like elements throughout. Thicknesses and dimensions of some components may be exaggerated for clarity.

Referring now to the drawings, a portion of a shoe press belt, designated broadly at **20**, is illustrated in **Figure 1**. The belt **20** has an endless looped polymeric matrix **21** that, in

the illustrated embodiment, includes a base layer **22**, axially-extending reinforcing fibers **24**, circumferentially extending reinforcing fibers **26**, and a top stock layer **28**. In the illustrated embodiment, the base layer **22** completely encapsulates the axial fibers **24** (which are typically positioned about 0.025" – 0.050" above the bottom surface of the base layer **22**) and extends about 0.020" above the tops of the axial fibers **24**. The circumferential fibers **26** are partially embedded (typically buried about halfway) in the base layer **22**. The top stock layer **28** covers and seals the circumferential fibers **26**; the top stock layer **28** cross-links with the base layer **22** and provides adequate thickness (typically between about 0.050 and 0.300 inches) for further finishing operations. A typical belt **20** may be between about 40 and 80 inches in diameter, 50 and 400 inches in length, and 0.100 and 0.300 inches in thickness.

Both the base layer **22** and top stock layer **28** are typically formed of a polyurethane-based material (*i.e.*, one that is primarily formed of polyurethane), preferably one having a hardness of between about 29 and 60 on the Shore D scale, or alternatively may be formed of polyester. The material may have fillers, additives and the like (for exemplary materials, *see* U.S. Patent No. 4,859,396 to Krenkel et al., the disclosure of which is hereby incorporated herein by reference in its entirety). It may be preferable to employ two different polyurethane-based materials for the base and top stock layers **22, 28**. For example, a slightly harder material (*e.g.*, one with a Shore D hardness of between about 29 and 45) may be used for the base layer **22**, which will be in contact with the shoe of a shoe press, and a slightly softer material (*e.g.*, one with a Shore D hardness of between about 45 and 60) may be used for the top stock layer **28**, which will be in contact with a press felt.

The reinforcing fibers **24, 26** may be formed of any suitable reinforcing material, but will ordinarily be formed of polyester, aramid, liquid crystal polymer, or other high performance fibers between about 0.008 and 0.050 inches in diameter. The fibers **24, 26** may be monofilament or multifilament strands. It is also contemplated that the fibers **24, 26** make take a flat, ribbonlike form, as this configuration may provide performance and manufacturing advantages.

Those skilled in this art will appreciate that, although a shoe press belt is described herein, a belt of similar structure may also be employed as a shoe calender belt; reference herein to a belt for a shoe press in intended to also include a belt for a shoe calender.

Referring now to **Figure 2**, the belt **20** may be formed on a mandrel **30**. Ordinarily, the mandrel **30** is supported at either end by bearings **35** on which it is rotatably mounted.

The mandrel **30** should have a cylindrical working surface **32** that is long enough to accommodate the largest anticipated paper machine working width (typically 400 inches), the additional length required to reach the shoe press heads (10 – 20 inches per end), the additional length required to form any belt tabs (10 – 20 inches per end) (*see* U.S. Patent No. Re 33,034 to Schiel for a description of belt tabs), and the space required to start and end the rotational cast process (12 inches per end). The length of the working surface **32** should be selected accordingly.

Preferably, the mandrel **30** includes a slightly undersized inner metallic or composite core **33** and a hard outer layer **34** (formed of rubber or some other easily worked material) that provides the working surface **32**. It is preferred that, if a separate outer layer is used and it is formed of an elastic or polymeric material, the outer layer is "bone-hard" (typically between 0 and 2 on the Pusey and Jones hardness scale), and that it be of sufficient thickness that, through grinding, the diameter can be modified to enable the formation of belts of slightly different diameters.

Prior to the application of polyurethane or other suitable polymeric material to the mandrel **30**, provisions may be made to the working surface **32** to assist with belt removal. Exemplary surface treatments include coating with mold release, wrapping with sheets of Teflon® or other low friction material, or the like.

After the mandrel **30** has been prepared, the axial reinforcing fibers **24** are loaded onto the ends of the mandrel **30**. In one embodiment of the invention, the axial fibers **24** are first formed into laminated multifiber bands (one of which is illustrated in **Figures 3** through **6A** and designated therein at **40**). The band **40** includes a plurality of fibers **24** (for example, 70 at a time) strung in parallel relationship and laminated at each end with lamination sheets **42** or other sheet material. Adhesive on the lamination sheets **42** can adhere the sheets **42** together; alternatively, the lamination sheets **42** can be heat-bonded. Other spacing material, such as a slotted card, may also be used to maintain the axial fibers in a desired spacing.

In the illustrated embodiment, tails **44** of the fibers **24** extend beyond the lamination sheets **42** and are knotted together. The knotted portions **46** of the band **40** are then secured to the ends of the mandrel **30** with tensioning hooks (not shown) mounted in a ring **36** located on the end of the mandrel **30**; if desired, the tensioning hooks may include a spring mechanism to maintain relatively consistent tension in the fibers **24**. In other embodiments, a grommet (designated at **48** in **Figure 6B**) or other suitable securing structure for attachment

to the mandrel **30** may be included in the lamination sheets **42** in place of the knotted portions **46**.

The lamination sheets **42** may maintain the fibers **24** at a desired uniform spacing between adjacent fibers **24** and at a desired distance from the working surface **32**. Alternatively, a spacer ring or toothed belt or chain (not shown) can be attached to the ends of the mandrel **30** to maintain the fibers **24** in these positions.

The axial fiber bands **40** can be formed, for example, with a fixture such as that designated at **49** in **Figures 5A** and **5B**. Axial fibers **24** are dispensed from individual creels **51** and threaded sequentially through a spacer board **53**, between vertically stacked rollers **55**, through second and third spacer boards **57a, 57b** (passing through a tensioning weight **59** between the spacer boards **57a, 57b**), and through a narrower spacing card **61** that positions the fibers **24** in a desired regular gapped relationship (typically, the gap between adjacent fibers is between about 0.030 and 0.250 inches). The fibers **24**, while remaining in the gapped relationship, extend to a platform **63** that slides on rails **67** (driven by a screw **65**) away from the spacing card **61**. The platform **63** includes hooks (not shown) onto which the knotted portions **46** of the band **40** are hooked.

Referring still to **Figures 5A** and **5B**, the band **40** is produced by locking the holding rollers **55** so that the fibers **24** do not slip, creating a desired tension in the fibers **24** by sliding the platform **63** along the rails **67** with the screw **65**, and laminating either one or, preferably and as shown, two sections of the fibers **24** near the spacer card **61** with the lamination sheets **42a, 42b**. Doing so completes the production of one band **40**, which now has lamination sheets **42, 42a** on both ends, and begins the production of the next band **40**, which now has one end laminated with lamination sheet **42b**. The portions of the fibers **24** between the lamination sheets **42a, 42b** are cut and knotted, the band **40** is removed and stored, and the lamination sheet **42b** and its attached fibers are moved to and mounted on the platform **63** to complete the production cycle.

Referring now to **Figure 7**, after the axial fibers **24** have been loaded onto the mandrel **30** and are positioned as desired, the base layer **22** and circumferential fibers **26** are applied. The base layer **22** may be applied by a casting nozzle such as that designated at **50** in **Figure 7**. The base layer **22** is preferably applied to a thickness that fully embeds the axial fibers **24** (a thickness that exceeds the top of the axial fibers **24** by about 0.020 inches is preferred. During application, the nozzle **50** begins at one end of the mandrel **30** and moves

axially on a track (not shown) as the mandrel **30** rotates about its axis; in this manner, the working surface **32** of the mandrel **30** becomes coated with the base layer **22**.

Referring still to **Figure 7**, the circumferential fibers **26** are applied after application of the base layer **22** (preferably while the base layer **22** is still semi-soft) and before, during, or immediately after the application of the top stock layer **28** (in the illustrated embodiment, the circumferential fibers **26** are applied immediately before the application of the top stock layer **28**). Individual creels of fibers (not shown) are mounted on a cart (also not shown) that is attached to and moves axially in concert with a nozzle **56** that applies the top stock layer **28**; as many as six or more fibers **26** may be wound into the base layer **22** at once. In the illustrated embodiment, a rod **54** extends downwardly from the nozzle arm **58**; the rod **54** has a forked lower end **54a** that includes a cross-roller **54b** over which the circumferential fibers **26** are fed prior to application to the base layer **22**. The circumferential fibers **26** are tensioned by means known to those skilled in this art in order to control penetration of the circumferential fibers **26** into the base layer **22**. Preferably, the circumferential fibers **26** are tensioned such that they are buried halfway (i.e. half of the cross-section of the fiber **26** is buried) in the base layer **22** (this tension is typically between about 0.25 and 5 pounds). It is also preferred that the top stock layer **28** be applied shortly after (i.e., within 15 minutes) or almost simultaneous with of the winding of the circumferential fibers **26**, as doing so can encourage cross-linking between the base layer **22** and the top stock layer **28**.

Those skilled in this art will recognize that a belt can be formed with a single material pass (*i.e.*, formed as a one polymeric layer that embeds both the axial and the circumferential fibers **24, 26**) rather than the two-shot process described above. In that instance the polymeric matrix **21** is a single unitary layer. Other embodiments may include more than two layers. Such embodiments may include one layer the embeds the axial fibers **24**, another layer that embeds the circumferential fibers **26**, and a third layer that provides the contact surface with a press felt.

After application of the top stock layer **28**, the base layer **22** and top stock layer **28** of the polymer matrix **21** are cured to form the belt **20**. Once the belt **20** has been cured, post-curing operations can be carried out as the belt **20** remains on the mandrel **30**. Such operations may include trimming to the proper length and approximate thickness, grinding to its finished thickness, and venting (typically with the formation of blind drilled holes or

grooves). Other operations are described in PCT Application No. US02/06520, filed March 4, 2002, the disclosure of which is hereby incorporated herein in its entirety.

Once the post-curing processing of the belt **20** has been completed, the belt **20** is removed from the mandrel **30**. Removal can be carried out in any manner known to those skilled in this art.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as recited in the claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.

That Which is Claimed is:

1. An endless belt for a shoe press, comprising:

a polymeric matrix formed into an endless loop;

multiple bands of axial fibers, the fibers being embedded in the polymeric matrix, the bands including spacing material at each end that maintains a desired circumferential spacing between the fibers and further including securing structure that is adapted for securing the fibers to a mandrel; and

circumferential fibers that circumferentially overlie and are spaced from the axial fibers, the circumferential fibers being embedded in the polymeric matrix.

2. The endless belt defined in Claim 1, wherein the polymeric matrix includes an inner base layer, the axial fibers being embedded in the base layer, and an outer top stock layer that circumferentially overlies the base layer and the circumferential fibers.

3. The endless belt defined in Claim 1, wherein the spacing material is a sheet material.

4. The endless belt defined in Claim 1, wherein the securing structure is a grommet positioned in the spacing material.

5. The endless belt defined in Claim 1, wherein the securing structure is a knot tied in the ends of one or more fibers in each band of axial fibers.

6. The endless belt defined in Claim 1, wherein the axial and circumferential fibers are selected from the group consisting of polyester and aramid fibers.

7. The endless belt defined in Claim 1, wherein the axial fibers are spaced between about 0.030 and 0.250 inches from each other.

8. The endless belt defined in Claim 2, wherein the circumferential fibers are partially embedded in the base layer.

9. The endless belt defined in Claim 2, wherein the base layer is formed of a first polymeric material, and the top stock layer is formed of a second polymeric material that differs from the first polymeric material.

10. An endless belt for a shoe press, comprising:

a polymeric base layer formed of a first polymeric material;

axially extending fibers embedded in the base layer;

circumferential fibers that circumferentially overlie the polymeric base layer; and

a polymeric top stock layer that circumferentially overlies the circumferential fibers, the top stock layer being formed of a second polymeric material that differs from the first polymeric material.

11. The endless belt defined in Claim 10, wherein the axially extending fibers are selected from the group consisting of polyester and aramid fibers.

12. The endless belt defined in Claim 10, wherein the circumferential fibers are partially embedded in the base layer.

13. The endless belt defined in Claim 10, wherein the first and second polymeric materials are, respectively, polyurethane-based materials having different hardnesses.

14. The endless belt defined in Claim 13, wherein the first polymeric material has a hardness of between about 29 and 60 Shore D.

15. The endless belt defined in Claim 14, wherein the second polymeric material has a hardness of between about 29 and 60 Shore D.

16. A method of forming an endless belt for a shoe press, comprising the steps of:

securing axial fibers relative to a mandrel, the axial fibers being spaced apart from one another at desired intervals and extending substantially parallel to a longitudinal axis of the mandrel;

applying a polymeric base layer to the mandrel in a thickness sufficient to embed the axial fibers;

wrapping circumferential fibers onto the polymeric base layer with sufficient tension to partially embed the circumferential fibers in the polymeric base layer;

applying a polymeric top stock layer over the polymeric base layer and circumferential fibers; and

curing the base layer and the top stock layer.

17. The method defined in Claim 16, wherein the wrapping step comprises wrapping the circumferential fibers at a tension of between about 0.25 and 5 pounds.

18. The method defined in Claim 16, wherein the axial and circumferential fibers are selected from the group consisting of polyester and aramid fibers.

19. The method defined in Claim 16, wherein the base layer is formed of a first polymeric material, and the top stock layer is formed of a second polymeric material that differs from the first polymeric material.

20. The method defined in Claim 19, wherein the first and second materials are polyurethane-based materials.

21. The method defined in Claim 16, wherein the wrapping step immediately precedes the step of applying the top stock layer.

22. The method defined in Claim 16, wherein the mandrel includes a polymeric outer surface.

23. A method of forming an endless belt for a shoe press, comprising the steps of:

securing axial fibers relative to a mandrel, the axial fibers being spaced apart from one another at desired intervals and extending substantially parallel to a longitudinal axis of the mandrel;

applying a polymeric base layer to the mandrel in a thickness sufficient to embed the axial fibers, the base layer being formed of a first polymeric material;

wrapping circumferential fibers onto the polymeric base layer;

applying a polymeric top stock layer over the polymeric base layer and circumferential fibers, the top stock layer being formed of a second material that differs from the first material; and

curing the base layer and the top stock layer.

24. The method defined in Claim 23, wherein the first and second polymeric materials are polyurethane-based materials.

25. The method defined in Claim 23, wherein the first polymeric material has a hardness of between about 29 and 60 Shore D.

26. The method defined in Claim 25, wherein the second polymeric material has a hardness of between about 29 and 60 Shore D.

27. The method defined in Claim 23, wherein the wrapping step immediately precedes the step of applying the top stock layer.

28. A method of forming an endless belt for a shoe press, comprising the steps of:

securing axial fibers relative to a mandrel, the axial fibers being spaced apart from one another at desired intervals and extending substantially parallel to a longitudinal axis of the mandrel, the axial fibers being maintained in spaced relationship by a spacing material applied at the ends of the fibers;

applying a polymeric base layer to the mandrel in a thickness sufficient to embed the axial fibers;

wrapping circumferential fibers onto the polymeric base layer;

applying a polymeric top stock layer over the polymeric base layer and circumferential fibers; and

curing the base layer and the top stock layer.

29. The method defined in Claim 28, wherein the spacing material is a sheet material.

30. The method defined in Claim 28, wherein the axial fibers are arranged as multiple bands of fibers, each of the bands of fibers being secured relative to the mandrel.

31. The method defined in Claim 29, wherein the fibers are secured relative to the mandrel with a securing structure.

32. The method defined in Claim 31, wherein the securing structure is one of a knot formed from the ends of the fibers and a grommet positioned in the sheet material.

33. The endless belt defined in Claim 28, wherein the axial and circumferential fibers are selected from the group consisting of polyester and aramid fibers.

34. The endless belt defined in Claim 28, wherein the axial fibers are spaced between about 0.030 and 0.250 inches from each other.

35. The endless belt defined in Claim 28, wherein the wrapping step causes the circumferential fibers to become partially embedded in the base layer.

36. The endless belt defined in Claim 28, wherein the wrapping step immediately precedes the step of applying a top stock layer.

37. The endless belt defined in Claim 28, wherein the wrapping step is performed prior to curing of the base layer.

38. The endless belt defined in Claim 28, wherein curing of the base and top stock layers occurs simultaneously.

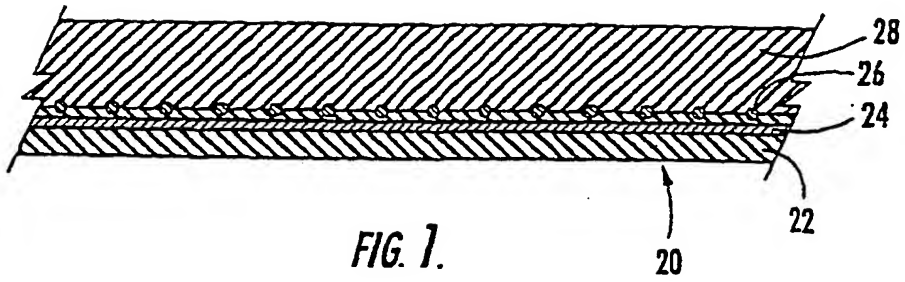

FIG. 1.

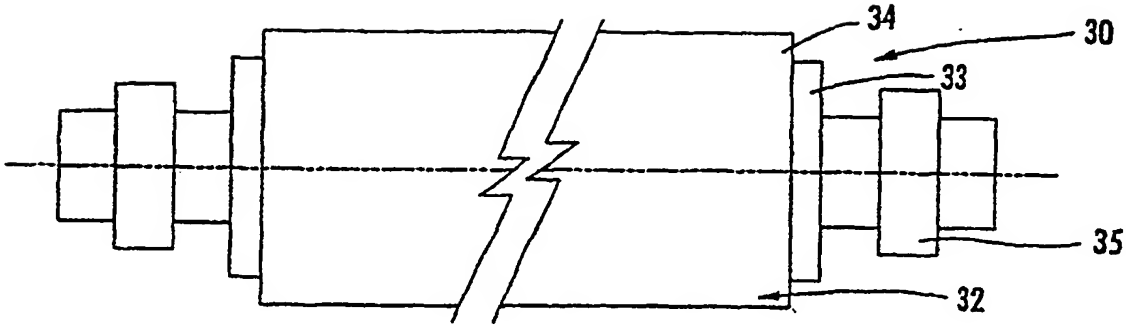

FIG. 2.

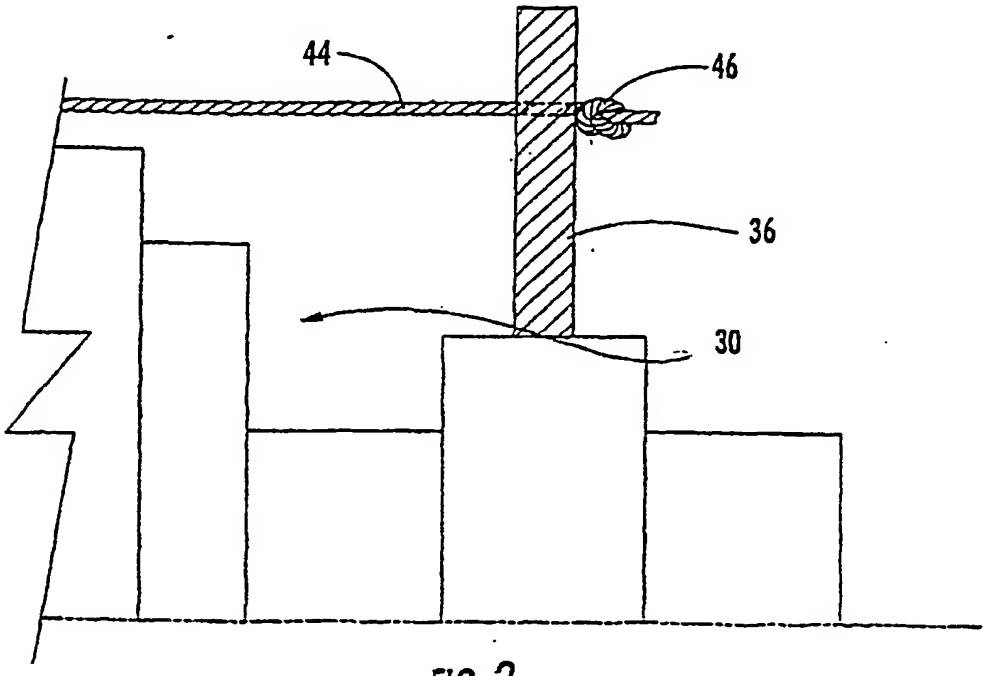

FIG. 3.

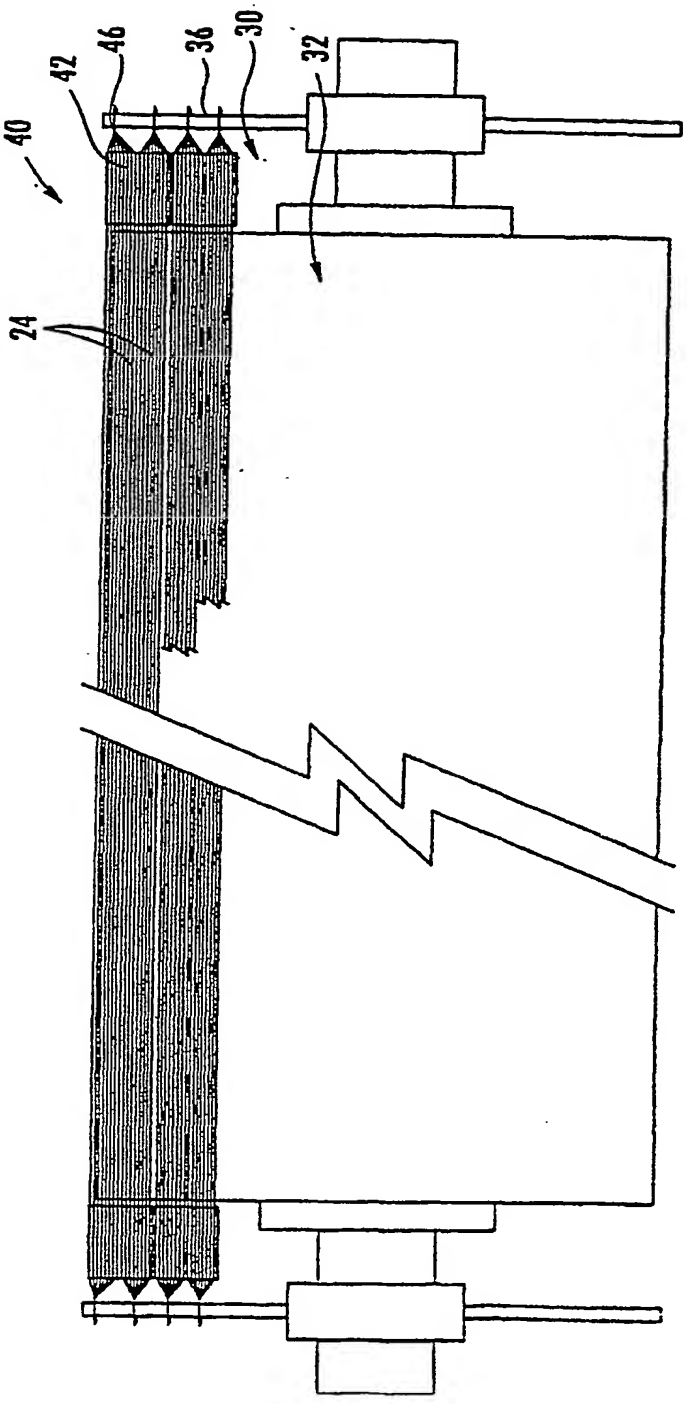

FIG. 4.

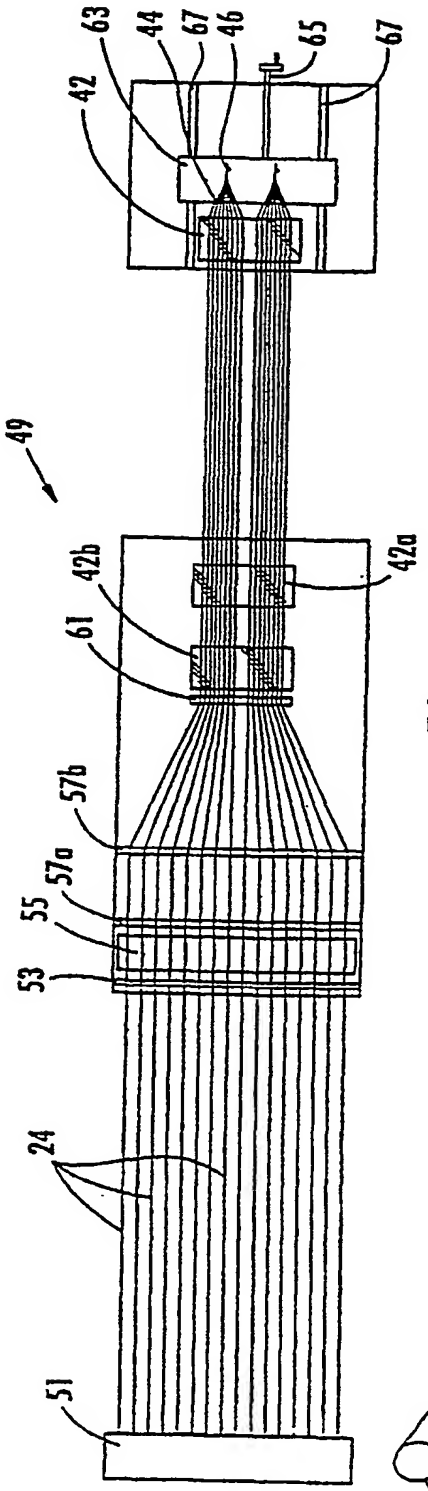

FIG. 5A.

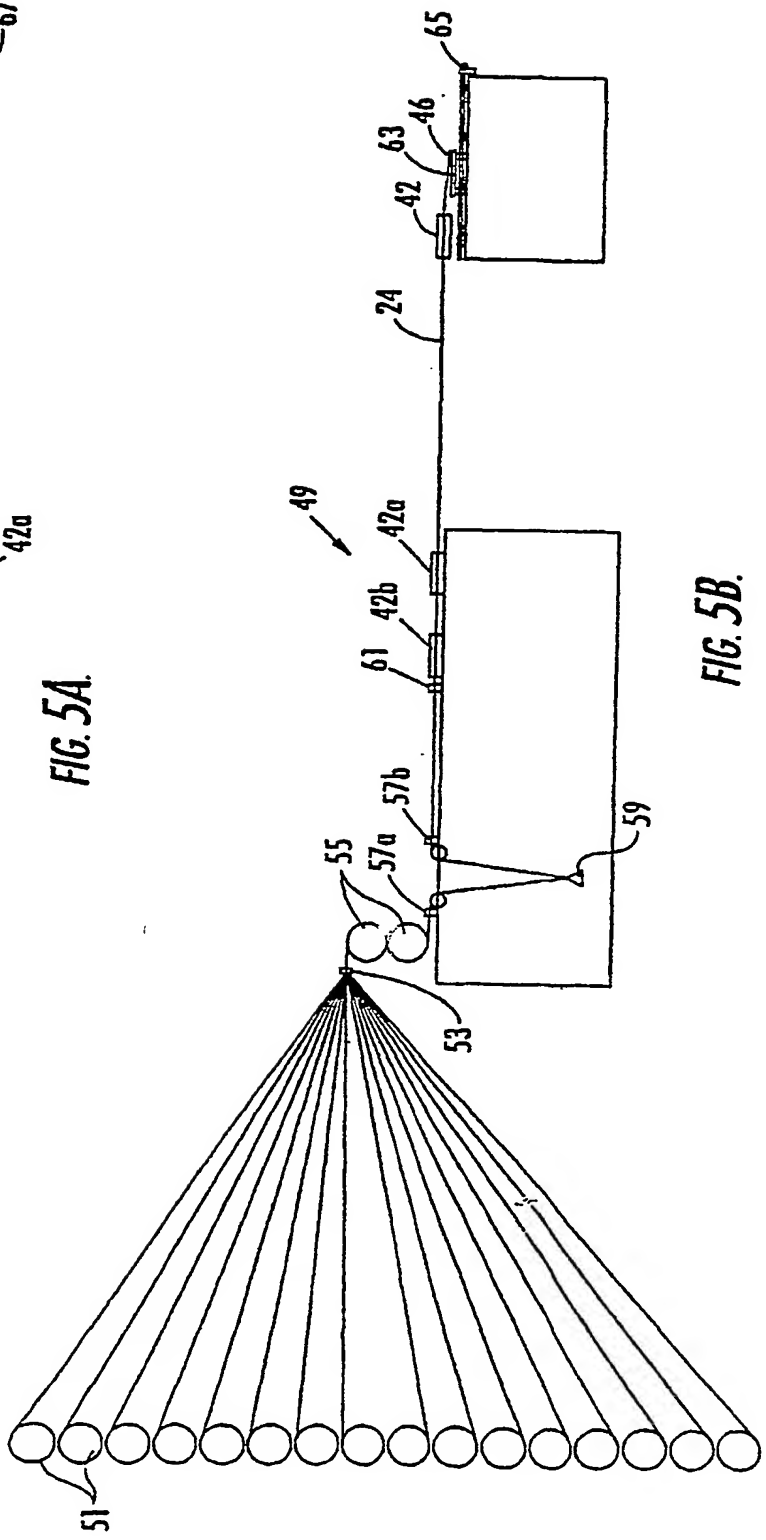

FIG. 5B.

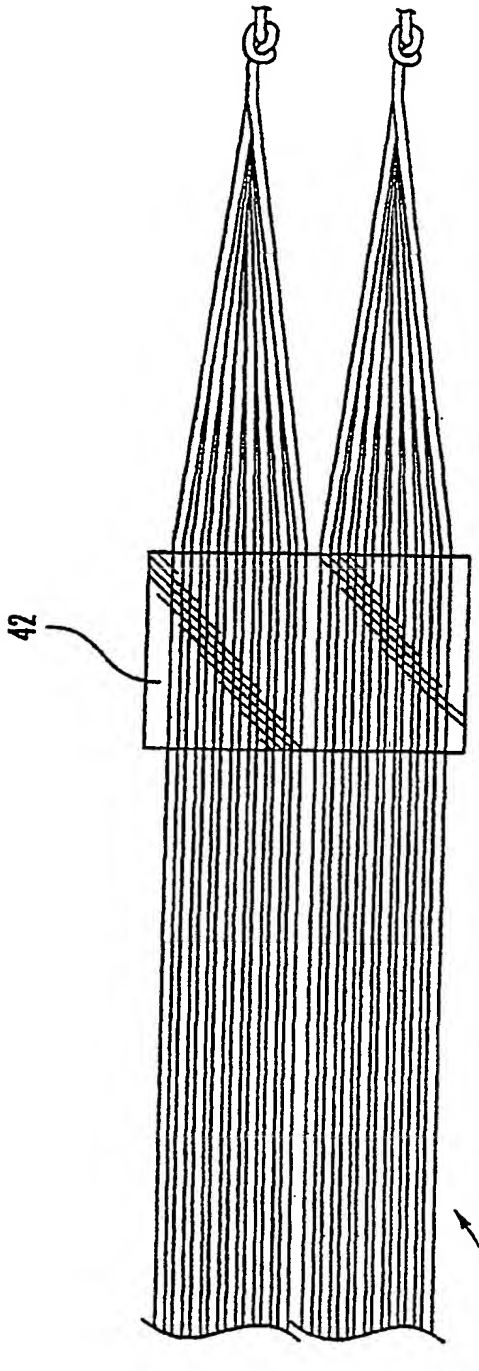

FIG. 6A.

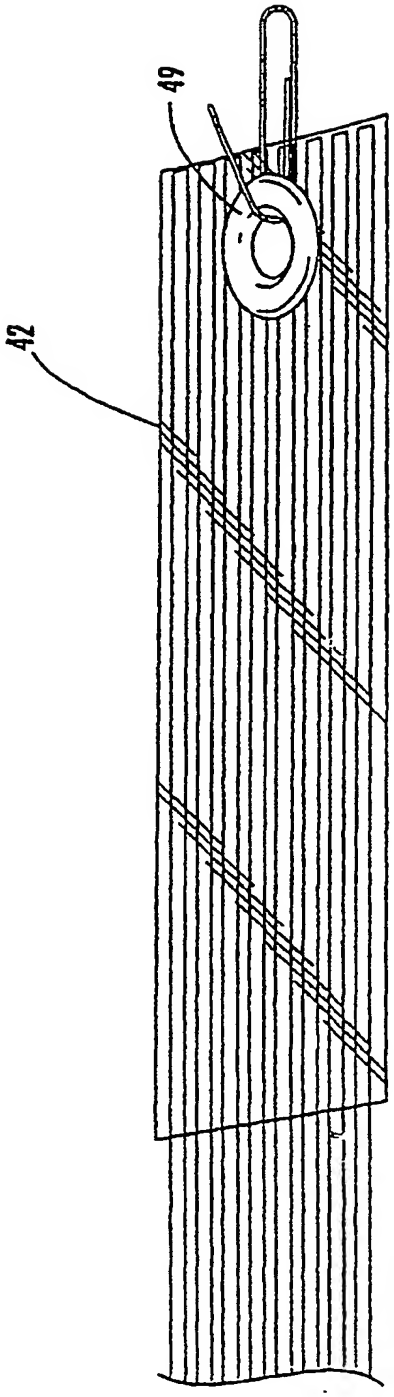

FIG. 6B.

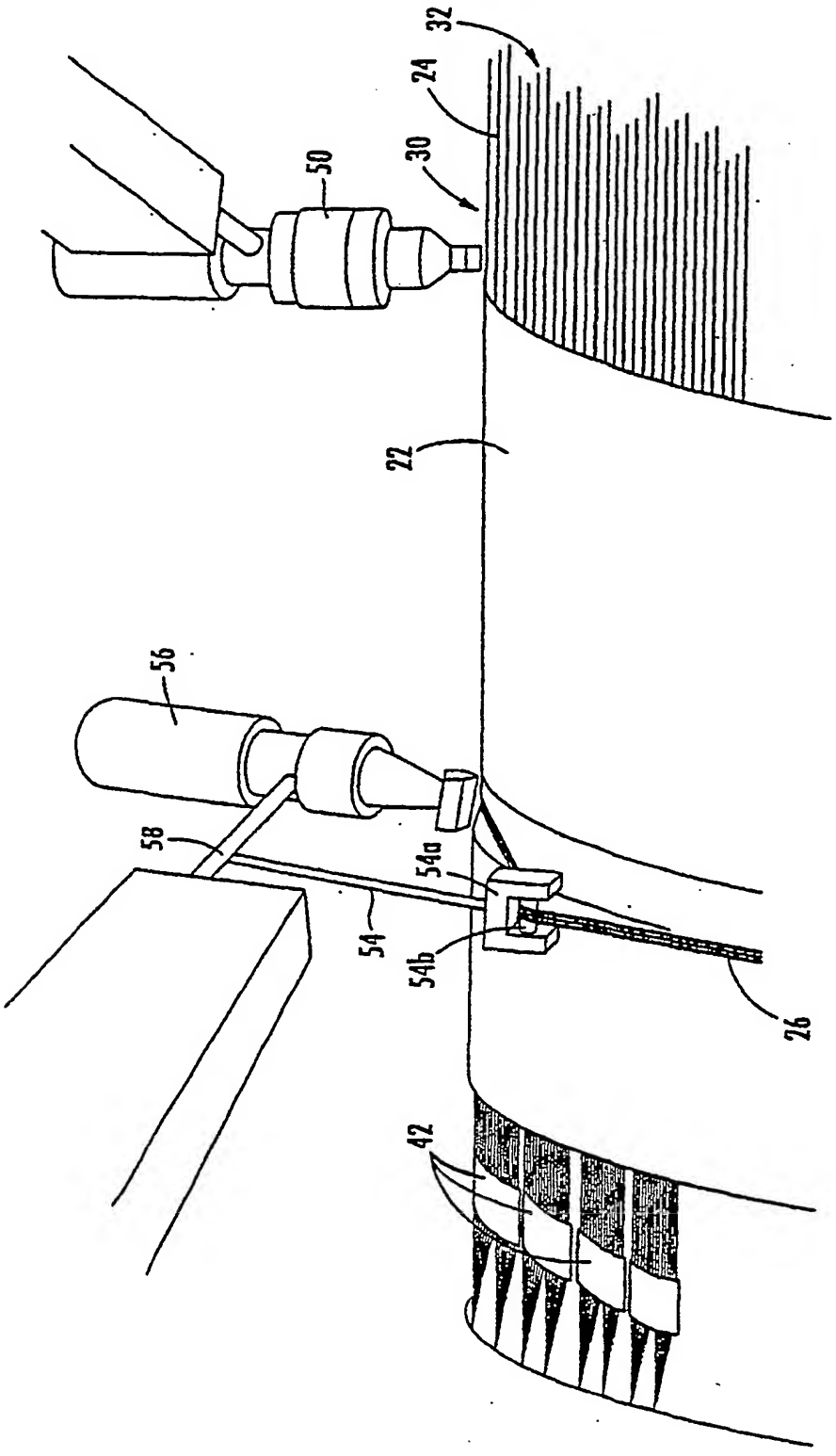

FIG. 7.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/15319

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D21F3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 118 391 A (AUFRECHT HARALD ET AL) 2 June 1992 (1992-06-02) cited in the application column 4, line 66 -column 7, line 6; figures 4-6	1,2,8, 28,35-38
Y	EP 1 096 065 A (ICHIKAWA CO LTD) 2 May 2001 (2001-05-02) column 6, line 1 - line 53 figures 8-10	10-15, 23-27
A		1,2,6-8, 28,33-38
Y	DE 44 11 620 A (VOITH SULZER PAPIERMASCH GMBH) 5 October 1995 (1995-10-05) column 3, line 54 -column 4, line 50 figures 2,4	10-15, 23-27

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 September 2003	18.09.03

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Maisonnier, C

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 41 25 470 C (VOITH GMBH J M) 12 November 1992 (1992-11-12) column 3, line 4 - line 23 column 4, line 21 - line 39 figure 3	14,15, 25,26
Y	DE 44 38 354 A (VOITH SULZER PAPIERMASCH GMBH) 2 May 1996 (1996-05-02) column 4, line 23 - line 25 figure 1	11
A	DE 43 40 344 A (VOITH GMBH J M) 7 April 1994 (1994-04-07) column 2, line 9 - line 45 figures 1,2	1,10,23, 28
A	DE 196 54 194 A (VOITH SULZER PAPIERMASCH GMBH) 25 June 1998 (1998-06-25) column 3, line 1 - line 38 claims 1,2,4 figure 1	10,13

INTERNATIONAL SEARCH REPORT

.....rnational application No.
PCT/US 03/15319

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [X] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

1-15,23-38

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-9, 28-38

   Belt comprising a polymeric matrix in which axial fibres are embedded, the axial fibres being maintained in spaced relationship during formation of the belt by a spacing material applied at the ends of the fibres.

2. Claims: 10-15, 23-27

   Belt having axial fibres embedded in a polymeric base layer, circumferential fibres wrapped onto the base layer and a polymeric top stock layer applied over the base layer and circumferential fibres, the top stock layer being made from a material that differs from the one from which the base layer is made.

3. Claims: 16-22

   Method of forming a polymeric belt in which circumferential fibres are wrapped onto a polymeric base layer with sufficient tension to partially embed the circumferential fibres in the base layer.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 03/15319

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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